NASA SBIR/STTR Technologies

A2.02-9001 - The key innovation of this effort is to develop a novel systematic verification and validation framework for adaptive learning flight control systems

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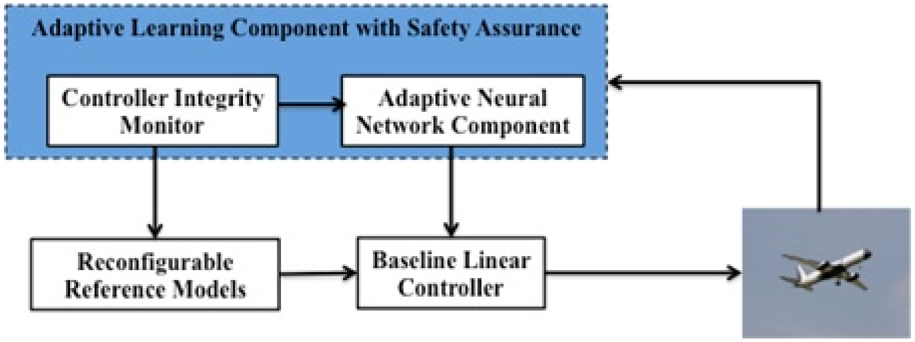
Identification and Significance of Innovation

The key innovation of this effort is to develop a novel systematic verification and validation framework for adaptive learning flight control systems towards real-time safety assurance and trusted autonomy. The proposed architecture has three main components. (1) A neural network based adaptive controller is designed to achieve robustness to modeling uncertainty and achieve fault-tolerance. (2)A novel integrity monitoring scheme based on Lyapunov stability theory is developed for the adaptive controller to detect unstable learning conditions and controller malfunctions. (3) A certified simple baseline controller operating with degraded control objectives is employed to assure system safety upon detection of controller malfunctions. The proposed architecture can potentially maximize the use of advanced adaptive controller with high performance capabilities, while ensuring the safety of the overall flight control system in the presence of unanticipated hazards.

Estimated TRL at beginning and end of contract: (Begin: 3 End: 4)



Technical Objectives and Work Plan

Phase I objectives and associated tasks are as follows:
1. Meet with the NASA scientists/engineers and determine any additional requirements of the project.
2. Custom design the baseline robust controller and the NN-based adaptive controller for WSU's quadrotor UAV model.
3. Custom design the controller integrity monitoring method for detecting unstable learning behaviors.
4. System integration using WSU's real-time quadrotor test environment and conduct simulation studies.
5. Experimentally evaluate the performance of proposed scheme and carry out real-time demonstration.

NASA Applications

There are many potential NASA applications for this innovation, for instance, intelligent adaptive flight control systems, adaptive engine control, space exploration applications including mated flight vehicle coordination, docking, and control of autonomous robots, flyers, and satellites.

Non-NASA Applications

The proposed approach can potentially be used for many safety critical applications, including military and commercial aircraft, U.S. air transportation systems, unmanned aerial vehicles, autonomous robots, nuclear power plants, etc. It will lead to benefits in the form of improved safety, survivability, and superior control performance of safety-critical systems.

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